National Aeronautics and
Space Administration

Artemis Geospatial Data Team

January 2023

NASA

ARTEMIS

Background

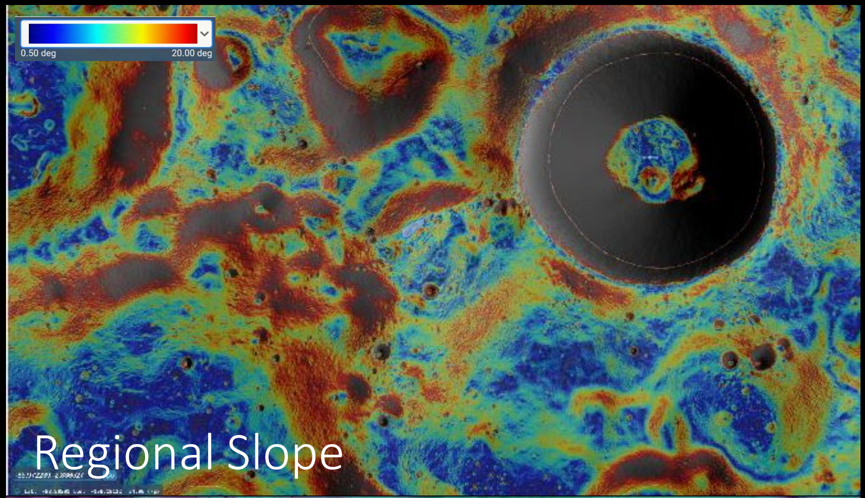
- The Artemis Geospatial Data Team was created in FY23 to bring expertise across NASA centers together as one team to help fulfill all Artemis related geospatial requests and perform the Lunar Surface Artemis Campaign safely and successfully
- The team generates, maintains, verifies, and distributes Artemis lunar data products, and supports a variety of Artemis activities:
  - Site selection
  - Mission planning
  - Mobility traverse analysis
  - Utilization support
  - Imagery and map creation for various use cases
- Data analysis infrastructure supports all internal stakeholders: Human Landing System (HLS), Extra Vehicular Activity (EVA), Lunar Terrain Vehicle (LTV), Pressurized Rover (PR), Science, Basecamp, and Operations
- Data analysis infrastructure has the capability to support external stakeholders, commercial providers, and public

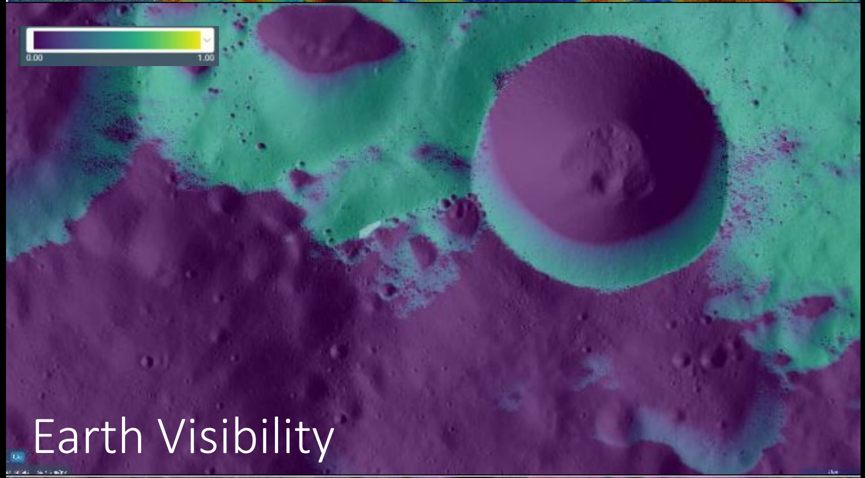
Team Capabilities

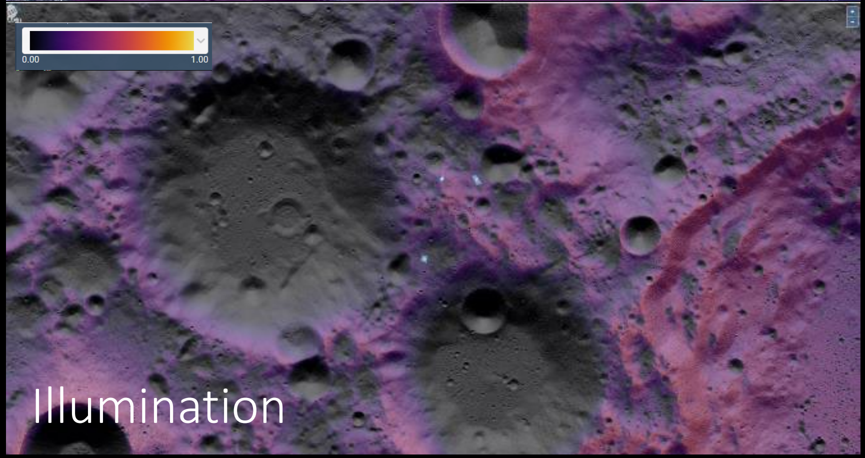
- The team provides services to the NASA community and providers, including:
  - Managing a data repository of graphical and numerical products
    - Digital Elevation Models (DEMs), visible image mosaics, surface property maps, vector data (local and regional scales)
  - Image processing
    - Raw to calibrated and map projected / orthorectified
  - Derived data product generation and classification
    - slope, terrain ruggedness index, hillshades, crater statistics
  - Visibility analysis (viewsheds) from observation points at or above the lunar surface
  - Visualizations for slope distribution and directional slope as a function of distance
  - Cartography (2D and 3D)
  - Landing site analysis/selection using spatial statistics
  - Simulation support with lunar landscaping
  - Basic and advanced least cost path traverse planning
- The team produces a variety of data products, including processed LROC NAC frames, LOLA maps, digital terrain models (DTMs), and derived products such as terrain ruggedness index (TRI) and hazard maps

Data Products

- Produce maps, analyses, and visualization products to inform mission planning, architectural inputs, and outreach activities
- Analysis products can be leveraged for future needs. Example: Hazard map of region once complete may be utilized for all use cases in that region
- These analytical and Customizable Maps will include, but not limited to, the following for a given location and timeframe:
  - Illumination
    - Images under various lighting conditions are required to build complete maps due to the incidence angles and dominate shadows near the pole
    - Lighting levels and temporal changes in lighting of a specified area for specific times
    - Lighting on trajectory approach
  - Topography and Contours
    - Earth/Solar Visibility
    - Comm link availability
    - High-res topo maps (e.g for TRN)
  - Regional slopes
  - High resolution (m-scale) images
  - Hazard maps
  - Utilization areas of interest maps
  - FOD simulation backbone data
  - Dimensions and Areas of interest (boundaries, thresholds, hazards)
  - Line of sight back to HLS, Hab
  - Crew training inputs
  - Acceptable Rover traverse paths based on model of rover and:
    - Rover power consumption
    - Acceptable levels of darkness
    - Rover speeds
    - Rover wheel width
    - Slopes
  - Artemis campaign asset built up
  - Surface Properties
    - Slopes, Soil composition, rocks/boulders, roughness, etc.
  - Validation/Verification



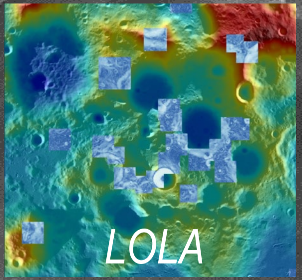




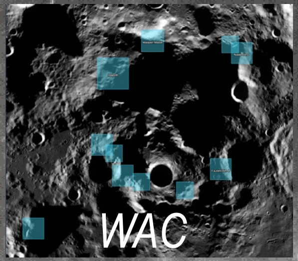
EXAMPLE WORKFLOW FOR LANDING: LEVERAGING EXPERIENCE

Initial Screening and Data Fusion (2022) → Detailed Analysis (2023) → Hazard Assessment and Surface Mission Planning (2023/24)

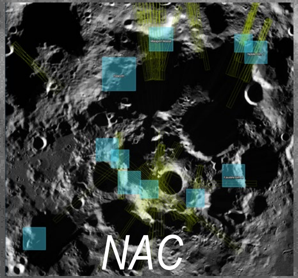
Initial Screening and Data Fusion (2022)



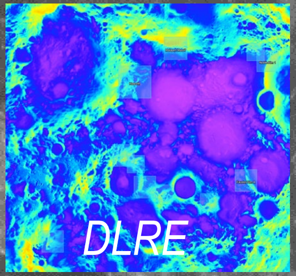
Create 5mpp DEM products
Initial screening
slopes,
comms
illumination moc



Establish Visual Basemaps
Observational illumination

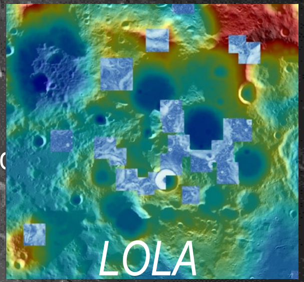


Identify NAC frames
Identify stereo observations
Assess image quality

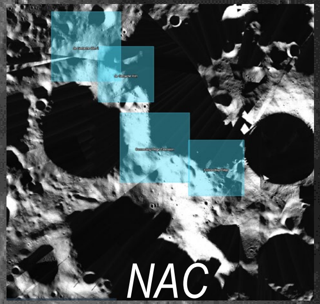


Estimate seasonal temperature

Detailed Analysis (2023)

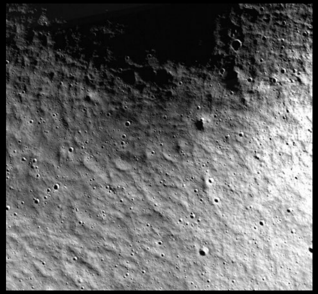


Roughness assessments
Improved Comm models



Establish semi-controlled NAC Mosaics
High-grade SfS locations
Preliminary Hazard Assessment
Detailed Hazard assessments for 2 locations

Hazard Assessment and Surface Mission Planning (2023/24)



Block Identification
Crater Counts

Slope Distributions
Roughness Assessment

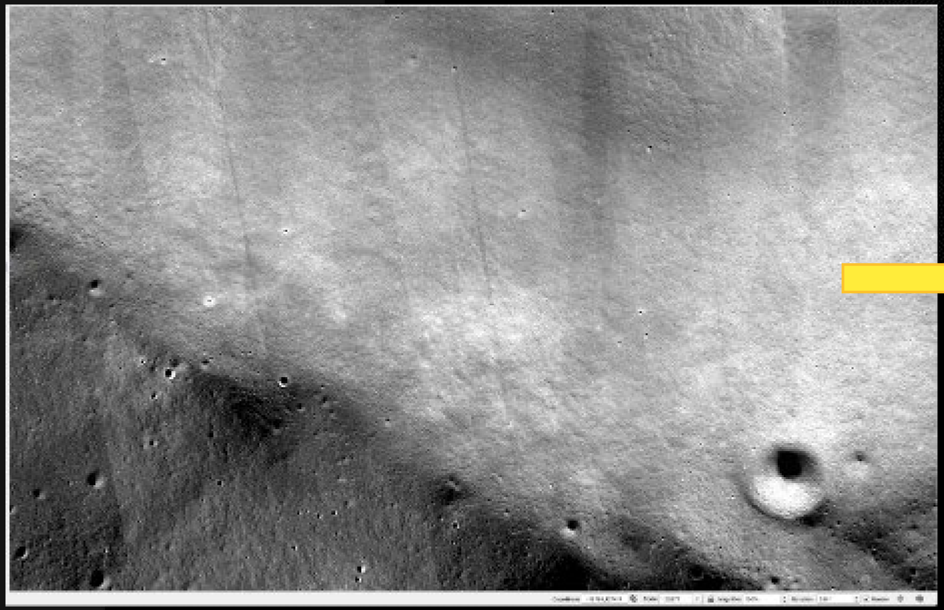
Integrated Hazard Assessment

Surface Mission Planning

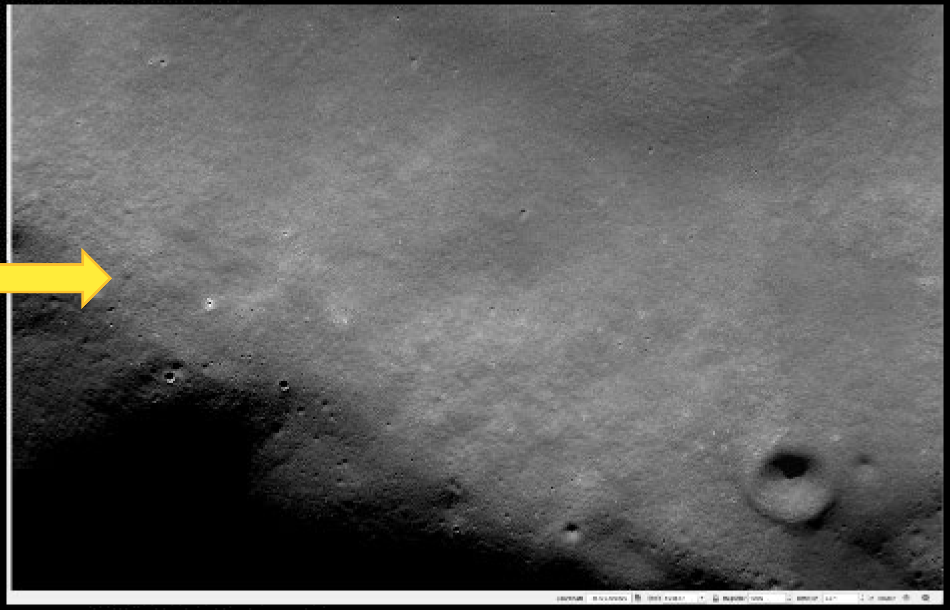
Successful Mission (safe landing and surface ops)

Image Processing

- Example: seamless mosaic of the Malapert region, near the Lunar South Pole. Comparison images show publicly available MoonTrek data from JPL/Ames and Artemis Geospatial Team recreated mosaic using select NAC data and additional image processing to create a smoothly blended map.



MoonTrek data from NASA JPL / Ames (Publicly Available)

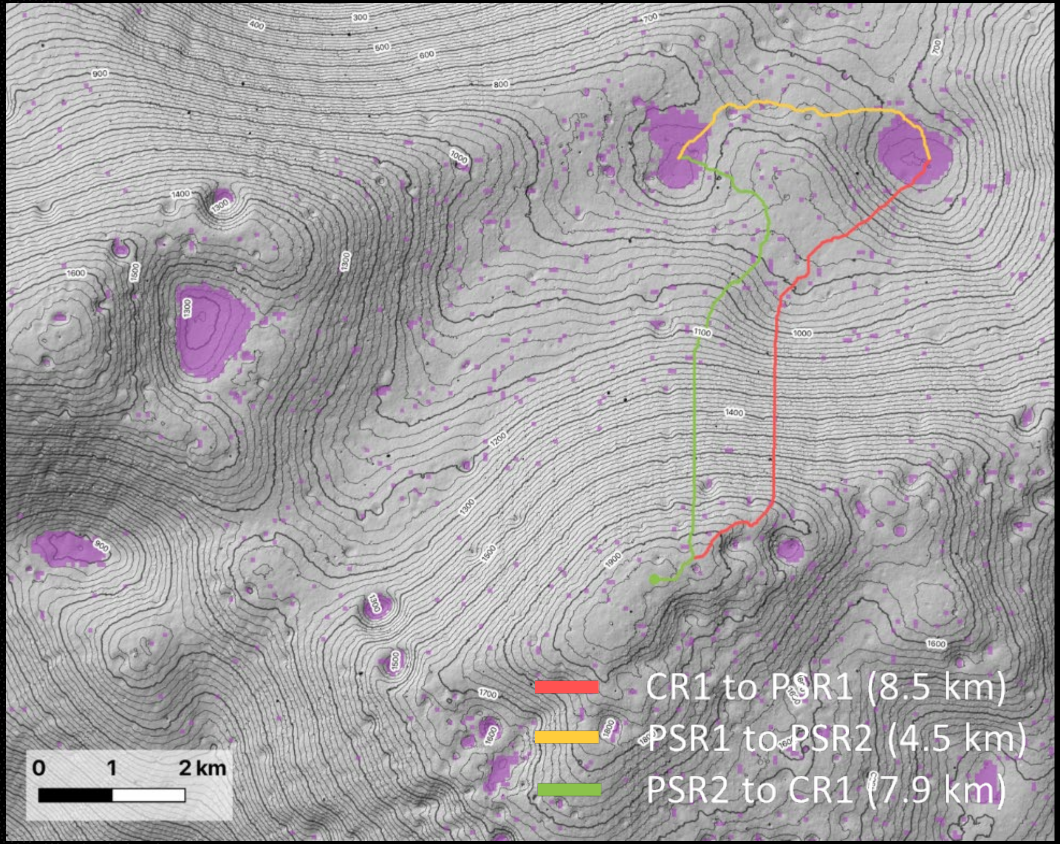


Blended mosaic of Malapert region created by Artemis Geospatial Team

Traverse Planning

- Determine notional traverse paths for astronauts and vehicles

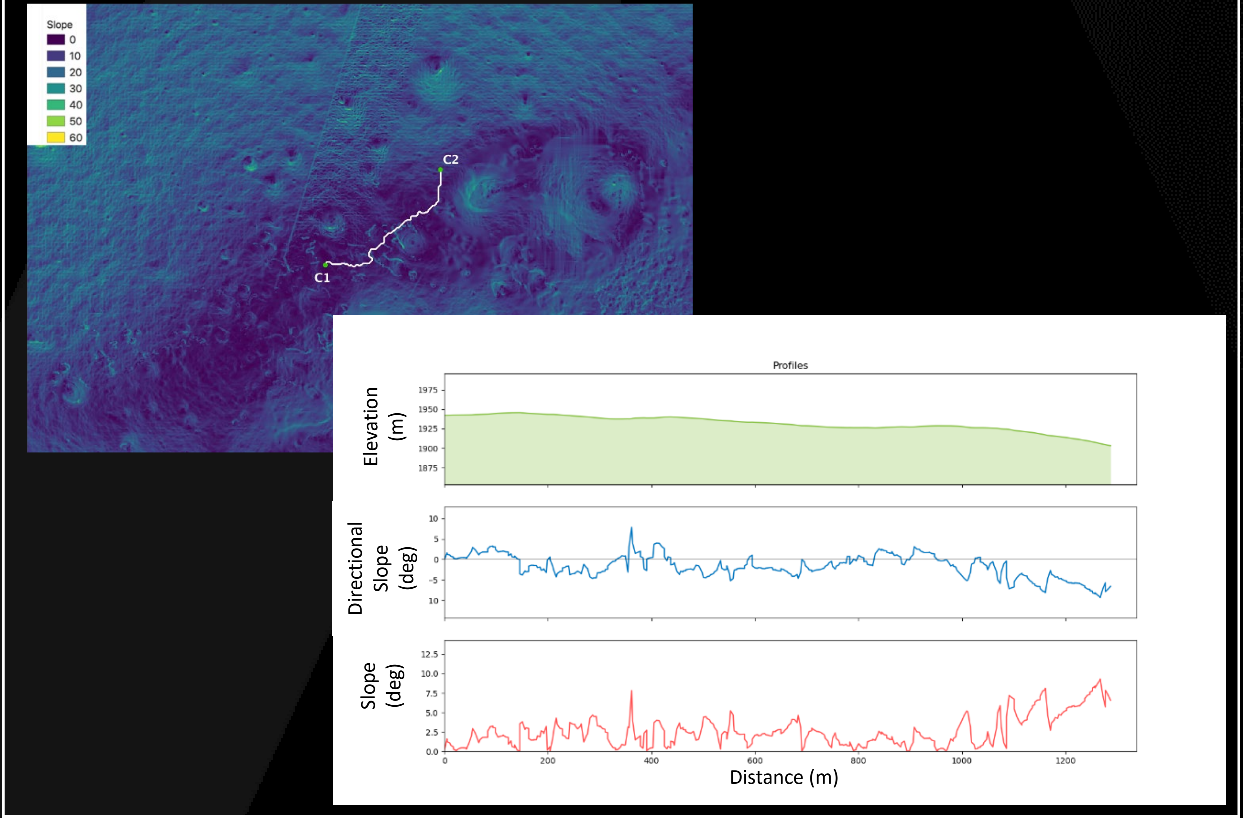
- Account for parameters such as slope, boulders, etc. using a least-cost path analysis (LCP). Output is minimum expense route from source to destination. Cost can be measured by slope, distance, or energy expended.



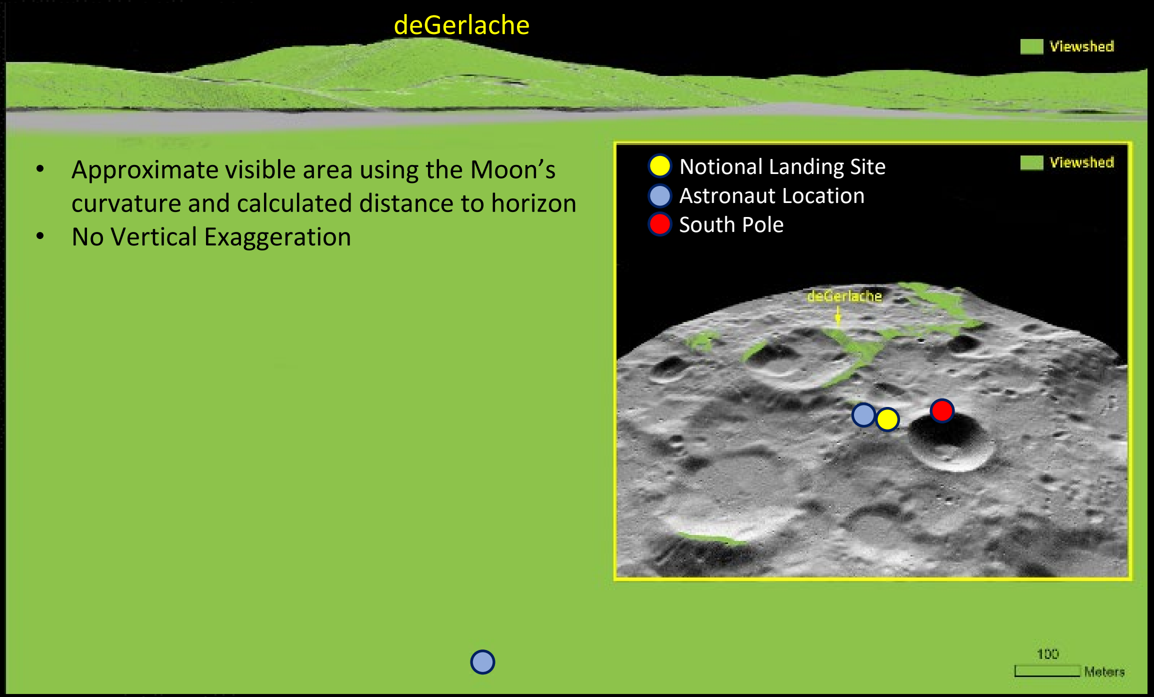
Topographic map of the Shackleton - de Gerlache Connecting Ridge, showing a round-trip traverse from CR1 to PSR1 and PSR2

Visualizations

- Data visualizations
  - Example: Traverse profile between two points, C1/C2, on the Shackleton - de Gerlache connecting ridge

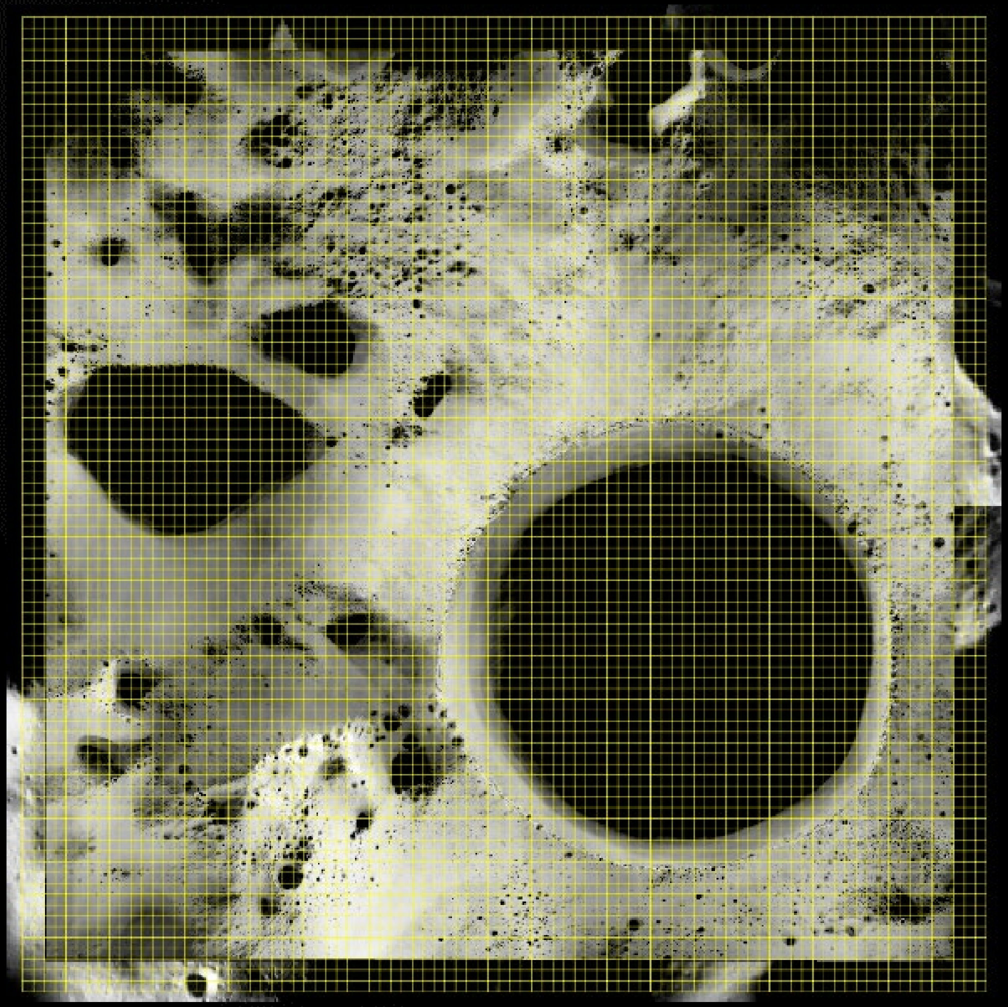


- Viewing perspective visualizations
  - Example: 3D perspective of an astronaut standing at a waypoint on the lunar surface



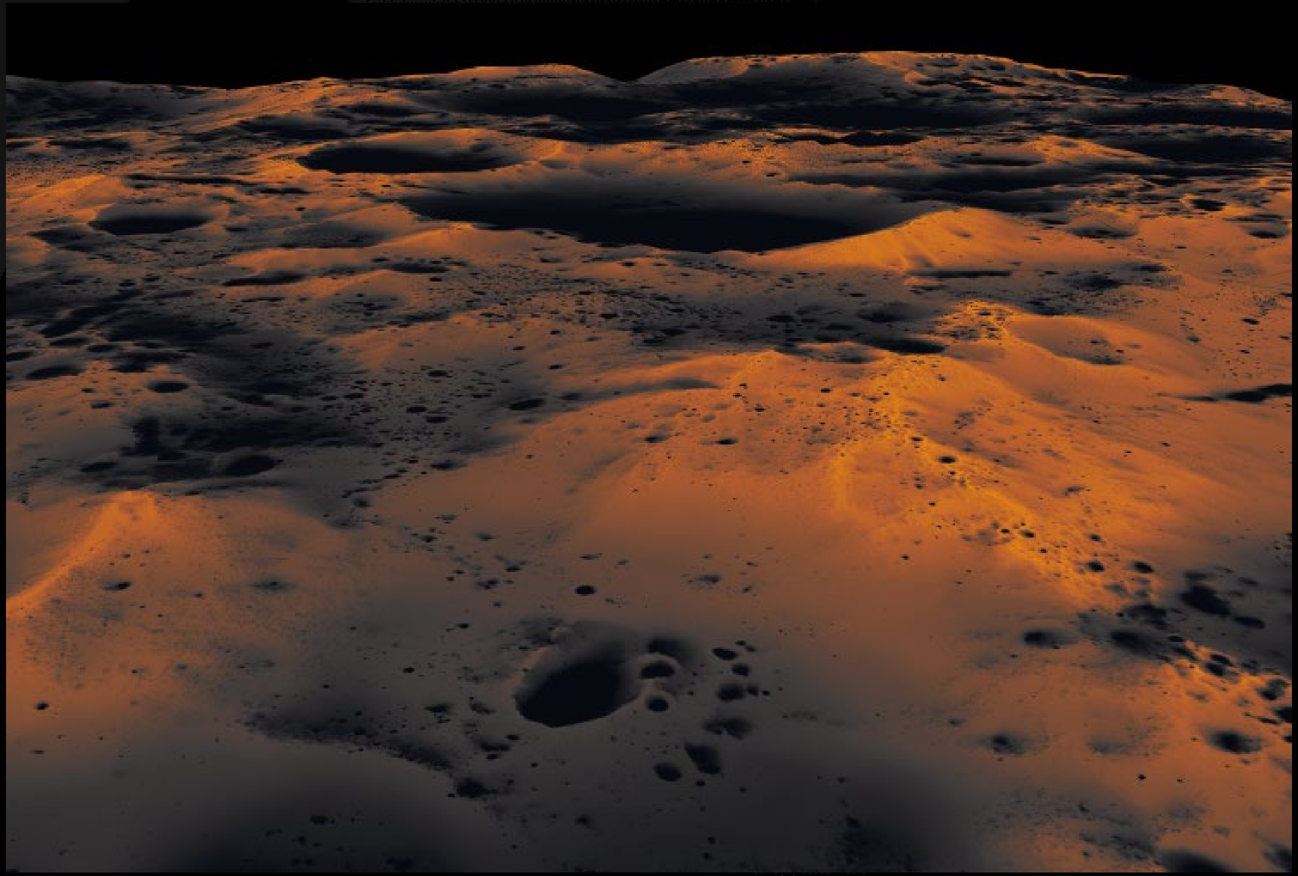
Lunar grids

- Developing an MGRS-analogous (Military Grid Reference System) grid system for lunar EVA mission planning
  - Determine the optimal grid size based on map scale and crew mobility



Example: 500m grid over NAC illumination and WAC morphology maps

Cartography (2D and 3D)



- Example: 3D view of average solar visibility overlaid on DEM near south polar region of the Moon
  - Orange = more illumination (averaged over ~18.6 lunar cycle)

Data Requests

Overview of the Data Request Process

- Write a brief statement with the requestor's name, the data needed, the need-by date, names and email addresses of other parties to be included on additional communication, and the purpose/program for which the requested data will be used

How to Initiate a Formal Data Request

- To request existing data products from the team, send the statement to:
  - jsc-artemisgeospatialteam@mail.nasa.gov